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(21) International Application Number: PCT/US92/11315 (22) International Filing Date: 30 December 1992 (30.12.92) (30) Priority data: 07/825,481 24 January 1992 (24.01.92) US (71) Applicant: E.I. DU PONT DE NEMOURS AND COMPANY [US/US]; 1007 Market Street, Wilmington, DE 19898 (US). (72) Inventors: CIUCA, James, Joseph ; 1510 Delaware Avenue, Apartment A3A, Wilmington, DE 19806 (US). EGAN, John, Daniel, Jr. ; 7 Seneca Circle, South Dartmouth, MA 02748 (US).		(74) Agents: BOYER, Michael, K. et al.; E.I. du Pont de Nemours and Company, Legal/Patent Records Center, 1007 Market Street, Wilmington, DE 19898 (US). (81) Designated States: CA, FI, NO, PL, RU, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). Published <i>With international search report.</i>
(54) Title: A FLEXIBLE POLYMERIC FOAM FOR USE AS AN INSULATOR AND A MOISTURE RETARDANT AND A PROCESS FOR PRODUCING IT <div style="text-align: center; margin: 20px 0;"> </div> (57) Abstract <p>A flexible polymeric sheet foam having insulating and moisture vapor retardant properties is installed beneath the interior surfaces drywall of a home. The flexible sheet foam may be located across or between wooden members which define the structure of the home. The sheet foam reduces energy losses between the interior of the home and the outdoors as a result of thermal conduction through wooden members of the home. The sheet foam may be fabricated by extruding a thermoplastic polymeric resin, and foamed by expansion or blowing agents.</p>		

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TITLE

A flexible polymeric foam for use as an insulator and a moisture retardant and a process for producing it.

5

FIELD OF THE INVENTION

The invention relates to a flexible polymeric foam sheet which is useful as an insulator and moisture vapor retardant.

10

BACKGROUND OF THE INVENTION

In conventional wall framing techniques which are used for construction of residential homes, as much as 23 % of the wall is wood. For example, wood members comprise the wall studs, trimmers, nailers, headers, among others. The remainder of the cavity defined within the residential wall is generally filled with insulation. The R or insulation value of the cavity may range from 19 to 21, however, the R value of the wood is approximately 1 per inch. As a result, energy loss occurs across or through the wood members which have a relatively low insulation value. In other words, the wood members conduct energy from the interior of the home to the outdoors, or vice versa.

20

In typical residential home construction, a thin polyethylene sheet is installed directly over the wooden members, and drywall is affixed to the wooden members through the polyethylene sheet. While this sheet functions as a vapor moisture retardant, the sheet has a nominal R value, and accordingly, lacks any significant affect on energy conduction through the wooden members.

SUMMARY OF THE INVENTION

The present invention relates to a flexible foam sheet which improves the insulation characteristics of structures within a home having wooden members, and also functions as a moisture vapor retardant. The flexible foam sheet may be incorporated during construction of residential homes by installing the flexible foam sheet across or between the wooden members on the interior face or side of the wooden members, and thereafter affixing drywall through the foam and into the wooden members, e.g., a nail or screw is driven through the drywall and the foam sheet, and into the wooden members. After having installed the foam sheet, the wooden members are insulated from the drywall or the interior of the home; thereby increasing the R value of the wall, reducing moisture vapor permeation, and exfiltration of conditioned interior air, e.g., heated or cooled air. The seams between the foam sheet may be sealed before installation of the drywall, thereby permitting the foam to function as a secondary air infiltration barrier.

The flexible foam sheet is produced by extrusion using conventional foam systems such as tandem, screw, stretched single screw, among others. A plurality of resins, virgin or recycled, or blends thereof, may be used for producing the flexible foam sheet. These resins are extruded and foamed using one or more foam expansion or blowing agents.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1-Fig. 1 is a cross-sectional view of a residential wall which may be formed in accordance with the invention that illustrates drywall installed over the flexible foam sheet.

Figure 2-Fig. 2 is a cut-away sectional view of the residential wall shown in Fig. 1.

DETAILED DESCRIPTION OF THE INVENTION

The invention relates to a flexible foam sheet which is located within the structure of a home in a manner that allows the foam sheet to reduce moisture vapor permeation and thermal conduction. The foam sheet is incorporated into the home by being affixed between or across at least the structural members, e.g., wooden wall studs, and thereafter, covered by the interior surface of the home. For example, a thin flexible extruded foam sheet is installed on at least one face of a wooden member such as a wall stud, in order to form a moisture vapor and thermal barrier within the wall. The interior surface such as drywall, ceiling components, flooring, among others, is installed over the foam sheet.

The foam sheet is installed by being affixed to the wooden members by any conventional and expedient technique. Conventional techniques include nailing, tacking, stapling, among others. As will be discussed below in greater detail, the foam sheet may be creased and folded during manufacture in order to enhance installation of the sheet foam. For example, an edge of a creased and folded foam sheet may be affixed to an upper portion of a wooden member, e.g., wall stud. After having affixed an edge of the foam sheet, the remainder of the sheet is unfurled or unrolled down the length of the wooden member. The unattached portions of the unrolled sheet foam are then readily affixed, e.g., stapled, onto the wooden member.

The seam which is formed between individual foam sheets may be sealed by any suitable technique. For example, the seam may be sealed by being taped using construction grade tape, e.g., TYVEK tape. It is also desirable to close or seam any other openings which may be present in the sheet foam. Openings in the foam, e.g., which may be provided for an electrical outlet, should be caulked or taped in order to ensure continuity of the moisture vapor barrier which is created by installing the foam sheet. The continuity of the foam sheet also enables the sheet to function as a secondary air infiltration barrier and a barrier to exfiltration of conditioned interior air, e.g., heated or cooled air.

After having affixed the sheet foam into a desired location, the interior surface of the residence is installed over or upon the sheet foam. The interior surface is installed by any conventional means such as nails, screws, among others. Typically, the interior surface comprises drywall which is installed upon the foam sheet, i.e., the drywall is indirectly attached to the wall studs. However, the sheet foam may be located throughout the residence, including beneath interior surfaces such as ceilings and floors, thereby enhancing the insulation and moisture

vapor retardance of the entire home. In other words, the foam sheet may be installed upon the wooden structural members of a home to provide a whole house liner or enclosure.

5 In one aspect of the invention, the sheet foam functions as a gasket by promoting a more uniform contact between the drywall and the wall stud. For example, the foam sheet which is directly affixed to the wall stud, compensates for surface irregularities of the drywall and/or the wall stud. The resultant interior wall surface has an improved surface quality or appearance which is desirable should the drywall be finished by painting, wall-papering, among others.

10 The flexible sheet foam of the invention typically has a thickness which ranges from about 1/16 to about 3/8 inches. The foam sheet may be extruded or formed into a virtually unlimited array of lengths and widths. Typically, the foam sheet which is packaged for residential installation will have dimensions such as 12 X 4, 12 X 6, 12 X 8, continuous lengths, among others. In some cases, it
15 may be desirable to laminate at least one surface of the foam sheet with or more facings, such as foil, fiberglass, NOMEX polymeric film, among others. By laminating the sheet foam, the characteristics of the foam may be tailored for a specific end use, e.g., enhanced vapor retardance, flame resistance, among others.

Referring now to the drawings, Figure 1 illustrates one manner in
20 which the flexible foam sheet can be incorporated into a residential wall. Figure 2 is a cut-away sectional drawing of the wall illustrated in Fig. 1, showing the wall as it would appear from the interior of the home. The exterior surface 10 of the home may be comprised of conventional exterior sheathing. Conventional exterior sheathing may comprise one or more of plywood, insulation such as rigid
25 polystyrene, phenolic or urethane foam, siding, shakes, clap board, stucco, among others. In some cases, a component of the exterior surface such as siding, shakes, clap board, among others, may be spaced apart from the sheathing by a fenestration system (not shown). The exterior surface 10 is attached to wooden members 11. The wooden members 11 may comprise one or more of wall studs, ceiling frame,
30 sub-flooring, among others. The space between the wooden members 11 typically defines a cavity 12 which is filled with insulation such as low density fiberglass batts, cellulose, blown-in-place insulation, among others. The flexible foam sheet 13 of the invention is installed, e.g., by stapling, directly upon the wooden members 11 and across cavity 12. The seams between individual sheets of foam 13 may be
35 sealed, for example by being taped (not shown). The interior surface of the wall 14

is installed over foam sheet 13 and affixed to the wooden members 11. Typically, the interior surface 14 comprises drywall which is nailed or screwed through the sheet foam 13, and into the wall studs 11. The interior surface 14 may be finished by using any suitable conventional technique such as painting, wall papering, carpeting, among others.

The flexible polymeric foam sheet discussed above may be obtained by foaming a suitable polymeric composition with a blowing agent comprising up to about 20 weight percent, based on the total weight of the composition, of at least one blowing agent selected from the group consisting of 1,1,-difluoroethane (HFC-152a); 1,2-difluoroethane (HFC-152); 1,1,1,2-tetrafluoroethane (HFC-134a); 1,1,2,2-tetrafluoroethane (HFC-134); 1,1,1-trifluoroethane (HFC-143a); and 1,1,2-trifluoroethane (HFC-143); pentafluoroethane (HFC-125), chlorodifluoromethane (HCFC-22), 1,1-dichlorodifluoroethane (HCFC-141b), 1-chloro 1,1-difluoroethane (HCFC-142b), among others. The blowing agent may also comprise one or more hydrocarbons such as butane, pentane and isomers thereof, among others, and/or atmospheric gases such as carbon dioxide and nitrogen. The blowing agent may further comprise methylformate, dimethylether and chemical blowing agents such as azodicarbonamide. Suitable polymeric compositions for foaming comprise one or more virgin and/or recycled resins such as at least one member from the group of consisting polyethylene, polystyrene, polypropylene, and thermoplastic polymers such as polyvinyl chloride, polyvinylidene chloride, polyacrylonitrile, polyethylene terephthalate, polybutylene terephthalate, polyesters, polyvinyl fluoride, ethylene copolymers, polyacrylates, among others. A suitable polymeric resin may also comprise an ionomeric resin which is a partially neutralized copolymer of an olefin and a carboxylic acid, e.g., SURLIN 9450. While particular emphasis is placed on producing a foam sheet comprising an ethylenic and/or a styrenic resin, it is to be understood that the present invention may be practiced by employing one or more of the polymers listed above.

HFC-134a and/or HFC-152a are particularly desirable for use as a blowing agent when forming polystyrene and polyethylene foams. HFC-134a enhances the insulating characteristics of the polystyrene foam because HFC-134a has a relatively slow permeation rate through this foam, i.e., a greater quantity of HFC-134a is retained within the foam which increases the R value of the foam.

In accordance with one aspect of the invention, it is often desirable to add a nucleating agent to the styrenic and/or ethylenic resin. These nucleating

agents serve primarily to increase cell count and reduce the cell size in the foam, and are typically used in an amount of about 0.1 part by weight to about 4.0 parts by weight per one hundred parts resin. For example, talc, sodium bicarbonate/citric acid, gaseous CO₂, calcium silicate, among others, are suitable nucleating agents for reducing cell size. Typically, the extruded foam sheet has a density which ranges from about 2.0 through about 8.0 pounds per cubic foot (pcf), and an average cell size of about 0.005 to 0.125, and normally about 0.010 to 0.125 inches in diameter.

An example of a composition which may be used for producing foam in accordance with the present invention comprises from about 0 to 5% talc, about 70 to 80% polyethylene having a density of about 0.9 grams per cc and a melt index of about 2.0 grams per 10 min, about 20 to 30% recycled polyethylene having a density of about 0.96 grams per cc and a melt index of about 0.6 grams per 10 min, and about 10 to 20% of a blowing agent based upon the total amount of the foam. Various additives, for example, fire retardant additives, color concentrates, stabilizers, anti-oxidants, lubricants, among others, may also be used depending upon the specific end use of the foam sheet.

Another aspect of the invention comprises a method for foaming a mixture of a styrenic and/or an ethylenic resin(s) and a polyfluorocarbon blowing agent. The method comprises producing a styrenic and/or an ethylenic foam by heating a resin in an extruder to produce a molten resin; introducing into the molten resin a blowing agent comprising at least one blowing agent such as HFC-152a and/or HFC-134a to produce a plasticized extrusion mass under a pressure sufficient which prevents excessive foaming of the extrusion mass; and extruding the extrusion mass through a die into a zone having a temperature and pressure sufficient to permit complete foaming of the extrusion mass; thereby providing the foam sheet. The foam may be extruded using conventional foam extrusion systems such as tandem, twin screw, stretched single screw, among others.

In a further aspect of the invention, the resin, e.g., styrenic resin, is mixed with a blowing agent and the resulting mixture is then foamed. The foaming is typically carried out with the use of an extruder, wherein the styrenic polymer is heated to about 400°-450° F to produce a molten polymer. The blowing agent is then introduced into the extruder wherein it is mixed with the molten polymer under pressures such that the resulting plasticized extrusion mass does not excessively foam, but its viscosity decreases. The extrusion mass is then cooled. Cooling increases the viscosity and the melt strength of the mass prior to extrusion. The

mass is then extruded through a die of any desirable shape at a controlled temperature, usually about 300° F, wherein the reduced pressure outside the extruder permits the extruded mass to foam.

5 The temperature and pressure conditions under which the resin and blowing agent mixture will not excessively foam will depend upon the particular resin being used and generally, will be a temperature which ranges between about 240° F and about 440° F, and a pressure above about 600 psig.

10 The conditions of temperature and pressure under which the extrusion mass will complete foaming, again will depend upon the particular resin used and generally, will be a temperature which ranges between about 240° F and 440° F but at a relatively low pressure. However, the more precisely the temperature is controlled throughout the extrusion process, the more uniform the resulting foam.

15 The degree of melt plasticization is controlled by the choice of the particular blowing agent composition, the amount of and type of nucleating agent or other additive(s) present, the particular resin or mixture being used and the Tg or Tg's of the resin(s), and the temperature, pressure in the extruder and the extrusion rate. The shaping means used can also affect the orientation of the polymer.

20 In practicing a method of the invention, the blowing agent may be added to the resin by injecting a stream of the blowing agent composition directly into the molten resin in the extruder. The blowing agent should be mixed thoroughly with the resin which is contained before the blowing agent and resin mass are extruded from the die. Thoroughly mixing the blowing agent and resin is desirable for producing a foam which has a generally uniform density and cellular
25 structure.

The extrusion mass comprising the molten resin and the blowing agent is normally extruded into an expansion zone within which foam formation and expansion takes place. Any suitable extrusion equipment capable of processing polymeric compositions into a flexible foam sheet can be used for the extrusion, e.g.,
30 single or multiple-screw extruders. Softening of the polymer and mixing with the blowing agent normally occur while working the polymer between flights of the screw or screws, which also serves to convey the extrusion mass to the extruder die. Screw speed and extruder barrel temperature should be sufficient to achieve adequate mixing and softening but not so high as to degrade the composition being
35 processed.

The resultant foam can be used in the as-manufactured flexible sheet configuration, cut into other shapes, further shaped or processed. For example, the flexible foam sheet may be creased in order to improve packaging of the foam as well as installation. A creased foam sheet is readily folded and prepared for shipment to the ultimate consumer. The consumer may then remove the folded foam sheet, affix one edge of the sheet to an upper end portion of a wooden member, and allow the folded foam sheet to unfurl or unroll. The remainder of the sheet is affixed to the wooden members in order to complete installation of the sheet.

While particular emphasis has been placed upon producing and installing a flexible foam sheet for use in residential home construction, it is to be understood that the foam may be used in any environment where properties such as moisture vapor retardance, insulating, and flame resistance, are desirable. For example, the sheet foam may be useful for providing insulation in a structure having metallic or masonry members. Further, installation of the foam sheet is not limited to new home construction because the foam sheet may be installed during a renovation and/or at any specific location which the properties of the foam sheet are desirable.

Certain aspects of the invention are demonstrated by the following Examples. It is to be understood that the following Examples are provided to illustrate, and not limit the scope of the invention.

Unless specified otherwise, the materials used in the following Examples are commercially available and substantially pure.

EXAMPLE 1

This example was conducted using a conventional tandem extrusion system. Foam was extruded through an annular die, stretched over a mandrel about 4 times the die's diameter, and slit to produce a single sheet.

The extrusion system was started using HCFC-22 as the blowing agent. After about 25 minutes, HFC-152a was introduced from cylinders pressurized with nitrogen.

In this example, two different foam sheets, "A" and "B" were produced using a 4.5 inch/6 inch tandem extrusion line; Sheet A, 10 g/100 square inches; Sheet B, 17 g/100 square inches.

The manufacturing and test data are presented in the following

Table 1.

	<u>Table 1</u>	
	Sheet A (10 g/100 sq.in.)	Sheet B (17 g/100 sq.in.)
<u>Formulation</u>		
Polystyrene (%)	95.3	96.5
HFC-152a (%)	4.4	3.1
Talc (%)	0.4	0.4
<u>Foam Product</u>		
Thickness (mil)	85	85
Density (pcf)	3.6	5.9
Cell size (mil)	3.9	8.0

EXAMPLE 2

A polyethylene foam sheet was produced using HFC-152a as the blowing agent in a commercial tandem extrusion system.

Foam was extruded through an annular die, then stretched over a mandrel with a diameter about 4 times that of the die to yield a foam tube which was then slit. The extruder and die operated at a pressure of about 750 psig, a resin melt temperature of about 210° F and a rate of about 300 lbs/hr. The HFC-152a blowing agent was injected at a rate of about 49.5-60 lbs/hr.

The process conditions which were used for producing the polyethylene sheet are summarized in the following Table 2.

	<u>Table 2</u>	
	<u>Blowing agent (BA)</u>	<u>HCFC-152a</u>
Die Pressure (psig)		760
Resin melt (°F)		208
Resin extrusion rate (lbs/hr)		295
BA extrusion rate (lbs/hr)		49.5-60
Foam density (pcf)		3.28-2.15

EXAMPLE 3

A flexible polyethylene foam sheet was produced generally in accordance with the process of Examples 1 and 2, with the exception that nitrogen was used as the blowing agent. The resultant foam sheet comprised low density cross-linked polyethylene foam, was about 1/16 inches thick, and had a density of about 4 pcf. This foam sheet was installed into a test panel, and analyzed substantially in accordance with ASTM Testing Procedure No. C236-87 to determine the insulating value of the sheet foam.

Two (2) test panels, each measuring about 4 X 6 feet, were constructed from 2 X 4 inch lumber, using a 16" center. Exterior grade plywood measuring about 1/2" thick was nailed to one side of the test panels to represent exterior sheathing. R-11 backed fiberglass insulation was placed into the cavity defined between the 2 X 4 lumber.

One of the test panels was used as a control wall. In the control wall a 4 mil solid cross-linked polyethylene sheet was stapled to the 2 X 4 lumber on the side opposing the plywood, and about 1/2 inch thick drywall was installed over the sheet. The second test panel was used for testing the foam sheet of the invention. In the second test panel, the foam sheet was installed in the same manner and location as the polyethylene sheet in the first test panel, and about 1/2 inch thick drywall was installed over the foam sheet. The ASTM test was performed on both panels. The results of the ASTM test are listed below.

	<u>CONTROL</u>	<u>TEST</u>
Thermal Resistance Value (R-Value)	12.5 HRxFt ² xF/BTU	14.3 HRxFt ² xF/BTU

The results of the test demonstrate that the foam sheet of the invention is capable of increasing the R-value of a wall by at least about 14%.

While certain aspects of the invention have been described above in detail, a person in this art will recognize that other embodiments and variations are encompassed by the appended claims.

THE FOLLOWING IS CLAIMED.

1. A process for producing a polymeric foam sheet comprising:
heating a polymeric resin to a temperature sufficient to provide a
5 molten polymer, wherein at least a portion of said resin comprises recycled resin,
adding and mixing at least one blowing agent with said molten
polymer to provide a plasticized mixture,
heating the mixture to a temperature and applying a pressure such
that the plasticized mixture such that the plasticized mixture substantially does not
10 foam, thereafter, reducing the temperature of the mixture to increase the viscosity
of said mixture; and
extruding the plasticized mixture into a foam sheet having a density
from about 2.0 to 8.0 pounds per cubic foot.
- 15 2. The process of Claim 1 wherein said resin comprises at least one of
polyethylene, polystyrene, an ionomeric resin, and polypropylene.
3. The process of Claim 2 wherein said resin comprises polyethylene.
- 20 4. The process of Claim 1 wherein said blowing agent comprises at
least one of HFC-152a, HFC-134a, dimethylether, nitrogen, and carbon dioxide.
5. A foam sheet product formed according to the process of Claim 3.
- 25 6. A foam sheet product formed according to the process of Claim 4.
7. The process of Claim 1 further comprising laminating at least one
facing material onto at least one surface of the foam sheet.
- 30 8. A process for improving the moisture vapor permeation and
reducing the thermal conductivity of a home comprising:
providing a structural member of a home having an exterior face,
affixing at least one polymer foam sheet, having a density of about 2.0
to 8.0 pounds per cubic foot, to the interior face of the structural member, and;
35 installing an interior surface member upon the polymer foam sheet.

9. The process of Claim 8 wherein said polymer foam sheet comprises polyethylene.

5 10. The process of Claim 8 wherein said structural member comprises at least one a wall, floor, and ceiling.

 11. The process of Claim 8 wherein said interior surface member comprises at least one of drywall and carpeting.

10 12. The process of Claim 8 further comprising sealing the seams between said foam sheets.

 13. The process of Claim 8 wherein said foam sheet further comprises
15 a laminate.

 14. An improved wall formed in accordance with the process of Claim
8.

20 15. An improved floor formed in accordance with the process of
Claim 8.

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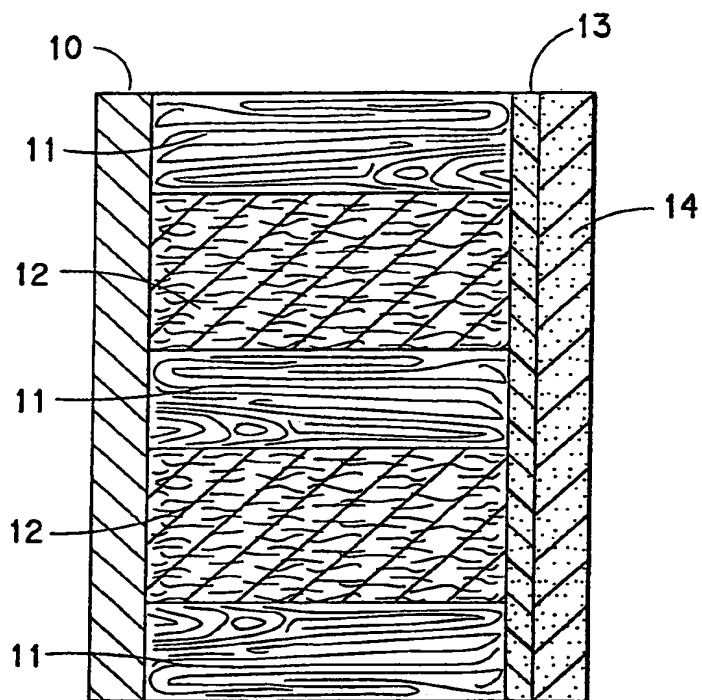


FIG. 1

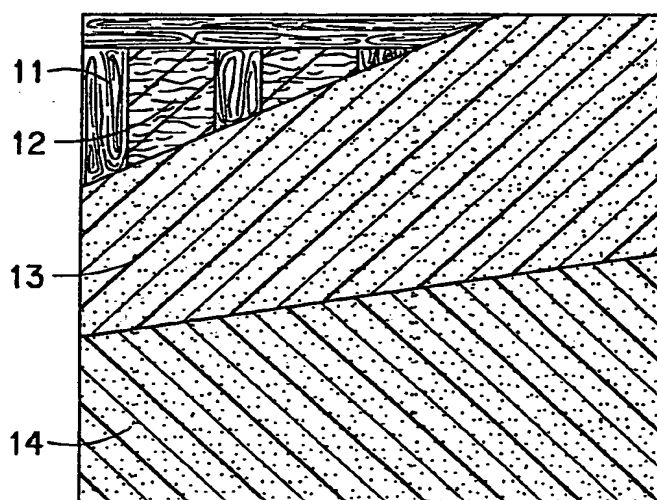


FIG. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 92/11315

A. CLASSIFICATION OF SUBJECT MATTER

IPC5: B29C 67/20, E04B 1/64

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC5: B29C, E04B, E04C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, CLAIMS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US, A, 4451417 (AKIYAMA ET AL.), 29 May 1984 (29.05.84), column 1, line 26 - column 2, line 21; column 4, line 8 - line 20, claim 1, abstract	1-11,13-15
Y	---	12
X	EP, A2, 0445847 (THE DOW CHEMICAL COMPANY), 11 Sept 1991 (11.09.91), claims 1-4, abstract	1,2,4,6,7
Y	---	3,5,8,10,11,13-15

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

6 April 1993

Date of mailing of the international search report

27 APR 1993

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 92/11315

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US, A, 4510268 (TONOKAWA ET AL.), 9 April 1985 (09.04.85), column 1, line 60 - column 2, line 16; column 3, line 8 - line 60; column 6, line 54 - line 66, claims 1,4, abstract	1,2,4,6,7,8, 10,11,13-15
Y	---	3,5,12
Y	US, A, 3160688 (A.A. AYKANIAN ET AL), 8 December 1964 (08.12.64), column 6, line 14 - line 40; column 6, line 68 - column 7, line 5, claim 1	3,5
Y	US, A, 3362120 (H.T. WARREN), 9 January 1968 (09.01.68), claims 1-4,7,8	8,10,11, 13-15
Y	US, A, 4071993 (STEWART ET AL.), 7 February 1978 (07.02.78), abstract	12
Y	US, A, 3638381 (ROBERTSON ET AL.), 1 February 1972 (01.02.72), claim 1, abstract	8,10,11, 13-15
A	WO, A1, 8806216 (PRUDHOE, ROBERT, KENNETH), 25 August 1988 (25.08.88), claims 1-29, abstract	8-15

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 92/11315

Box I Observations where certain claims were found unsearchable (Continuation of Item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of Item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Claims 1-4,7 concerns a process for producing a polymeric foam sheet and claims 5-6 concerns the foam sheet produced by the process of claims 1-4. Claims 8-15 concerns a process for improving the moisture vapor permeation and reducing the thermal conductivity of a home. It is not mentioned in claims 8-15 that the foam used is manufactured by the way in claims 1-4.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

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The additional search fees were accompanied by the applicant's protest.

No protest accompanied the payment of additional search fees.

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